SEL

FINAL SUBMISSION

ASSISTANCE OF A STATE DEPARTMENT OF TRANSPORTATION TO A RAILROAD IN SOLVING SOILS AND FOUNDATION PROBLEMS

by

Harry E. Schultz,
Assistant Chief Engineer of Staff,
Delaware and Hudson Railway Company

Taylor J. McDermott,
Design Engineer,
Delaware and Hudson Railway Company

Stephen E. Lamb,
Senior Soils Engineer,
New York State Department of Transportation

H. E. Schultz, T. J. McDermott, S. E. Lamb

ABSTRACT

This paper describes the informal assistance that soils engineers from the New York State Department of Transportation have provided in the past to the Delaware and Hudson Railway Company in the timely solution of several major embankment failures that interrupted traffic operations. Under the present New York State Railroad Service Preservation Bond Program, DOT engineering assistance is available to the railroads. Under this arrangement DOT soils engineers are investigating areas of recurring track maintenance caused by soils and water conditions. The goal is to develop solutions for permanent stabilization that will be more economical than continual maintenance.

The paper demonstrates that geotechnical engineering can have a significant input into reducing some of the expensive costs of track operation and maintenance caused by soils, water and foundation problems. In this case the service was provided by a highway geotechnical organization. Highway and railroad soils and foundations problems are shown to be similar. Involvement of railroad engineers in TRB activities should provide an opportunity to upgrade the level of geotechnical capabilities in railroad engineering organizations.

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H. E. Schultz, T. J. McDermott, S. E. Lamb

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This paper demonstrates the potential engineering assistance that a State DOT soils and foundation organization can provide to a railroad for the timely repair of major foundation problems that disrupt operations and for other soils related problems that require continuing maintenance.

Soils and foundation engineering has developed rapidly in the last 30 years. Many State transportation agencies have established units in their organizations to implement geotechnical engineering into the extensive highway design and construction programs over the last two decades. In this same time span most railroads have not had major construction programs and there has been little stimulus to develop soils and foundation expertise on their engineering staffs. Railroads and highways are similar facilities except for the travel way. Problems encountered with embankment, embankment foundations, and rock or earth cut slopes have similar solutions. Tracks and pavements are both located on the ground surface and the travel ways are both subjected to the climatic cycles of freeze-thaw, wet-dry that affect the performance of the subgrade soils and the pavement or ballast.

For the last 15 years members of the soils staff in the New York State Department of Transportation (NYSDOT) have provided informal assistance to the Delaware and Hudson Railway Company (D&H RR) in solving major soils and roadbed problems. The basis for this relationship is that headquarters of both organizations are in Albany and several DOT engineers had worked previously for the railroad.

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The D&H RR system in New York State extends from Pennsylvania to the Canadian border as shown in Figure 1. New York is a glaciated State and the major valleys contain soils deposited by vast quantities of glacial melt water as the ice sheet receded northward. The northern portion of the D&H RR is located in the Lake Champlain Valley which contains plastic clays of limited strength and other water laid deposits of coarser sand and gravel.

Both of the embankment problems described in this paper were major failures that disrupted service and required immediate repair without time for subsurface explorations and laboratory testing. Therefore there was a need for a soils engineer with experience with similar foundation problems to advise on the most expedient and correct action to take.

The first embankment failure problem occurred in 1963 involving a twenty foot high embankment located near the shore of Lake Champlain. Several days prior to the major failure, maintenance crews had repaired minor track settlement at the site. Additional settlement must have occurred, since the next day a northbound freight was derailed scattering numerous cars along the track north of the future failure area. A work train was sent to the site, cleared the tracks, and unfortunately backed off onto the unstable embankment settlement area while waiting for orders. Suddenly, the embankment and locomotives dropped twenty feet and simultaneously the bottom of Lake Champlain 150 feet distant rose 12 feet above the water. The details of this unusual failure are shown in

Figures 2 and 3. Figures 3 and 4 show the locomotives and the mudwave that exposed the lake bottom.

Soils engineers in the DOT were contacted for an appraisal of the failure and recommendations for restoration of the embankment in order to reestablish main line service. Inspection indicated that the area was underlain by a layered silt and clay deposit and the topography of the adjacent hillsides showed evidence that this was an area of ancient landslides. It was concluded that the initial settlements observed were caused by minor movements in the underlying clay. Although the embankment had been stable for thirty years, high groundwater conditions may have caused minor plastic movements in the foundation soil that contributed to the settlement that caused the derailment. However the major movement was caused by the weight of the locomotives and the vibrations generated by the idling engines. These vibrations apparently caused liquefaction and complete loss of strength in an underlying silt layer that resulted in the spectacular failure. Recommendations were to construct s stabilizing counterweight berm over the mudwave to the elevation shown in Figure 2. After the berm was completed the embankment was brought back to grade. This was done in two days and the area has presented no problem during the last 14 years.

At another location further north at Port Kent a major failure occurred in the spring of 1971. At this location the roadbed is on a side hill fill 40 feet above Lake Champlain as shown in Figure 5. The embankment was constructed 50 years ago against the face of a delta deposit of sand laid

down by post glacial rivers flowing from the Adirondack Mountains. Suddenly, during the spring thaw, a portion of the fill literally became liquified and slumped into the lake. Railroad maintenance forces placed emergency fill but this material also became unstable and flowed into the lake.

NYSDOT soils engineers were requested to provide recommendations for stabilizing this failure of the mainline embankment. Examination of the site indicated groundwater was emerging from the slide face. This groundwater flow must have increased significantly immediately before the failure since the winter frost had just become completely thawed and accumulated surface groundwater was able to flow downward into the delta deposit. The natural subsurface drainage direction in the deposit was toward the lake. The embankment had less permeability than the natural deposit and the groundwater head and seepage forces caused the fill to become unstable at its steep angle of repose resulting in the failure. It was decided that the best solution was to reconstruct the embankment with a pervious material to allow drainage and a lightweight material to reduce the load on the unstable fill previously placed. Readily available materials were ballast stone to provide permeability and a number of old gondola car bodies to decrease the embankment weight. The embankment was constructed to grade with the cars upside down as shown in Figure 6. The mainline was open to traffic in two days and the embankment has been stable since construction.

These two case histories demonstrate the potential technical assistance that an experienced soils organization can provide to a railroad for the

solutions of major foundation problems with a minimum involvement of manpower. This assistance was conducted on an informal basis.

In the past five years there has been an influx of Federal and State money for improvements to existing railroad systems. In 1970, New York State voters passed the Railroad Service Preservation Bond Act which approved $250 million for the maintenance and improvement of rail transportation facilities and services. NYSDOT was designated to administer this program. Engineering assistance by DOT is available to the railroads for the identification and development of projects eligible for funding.

The D&H RR recognized the value of the previous soils engineering services for their emergency problems. Under the new engineering assistance arrangement the railroad requested a soils investigation of an unstable embankment area adjacent to Lake Champlain. Subsurface explorations, laboratory testing and analyses were conducted to determine the most economical method to provide a stable embankment and design report was prepared for the railroad.

Under the same engineering assistance arrangement NYSDOT soils engineers with D&H RR engineers and maintenance personnel recently made a field survey of 100 miles of mainline track to locate areas of perennial maintenance problems caused by soil and water conditions. Some of these conditions causing maintenance problems are subgrade pumping of fine grained soils, erosion of finer soils through rip rap protection, unstable embankment foundations and cut slopes, and stream bank erosion. A report

is being prepared indicating the location of the soils related maintenance problems and suggested methods of permanent stabilization. It is probable that the cost of some recommendations may be greater than continuing maintenance. However for other problems permanent stabilization may be economically practical making long term savings possible through reduction of maintenance costs.

The engineering assistance arrangement described above does not obligate the railroad to comply with the DOT engineering recommendations to be eligible for State funds. The railroad is responsible for the final decisions and policies involving engineering operations. The geotechnical engineering services of NYSDOT are available in order to provide the most economical and adequate solution of maintenance and operation problems for the mutual benefit of the railroad and the State.

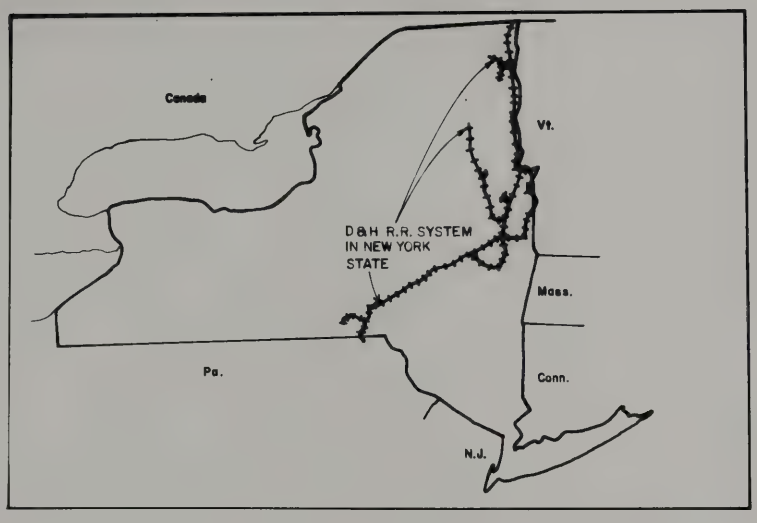

FIGURE 1

D&H R.R. SYSTEM IN NEW YORK STATE

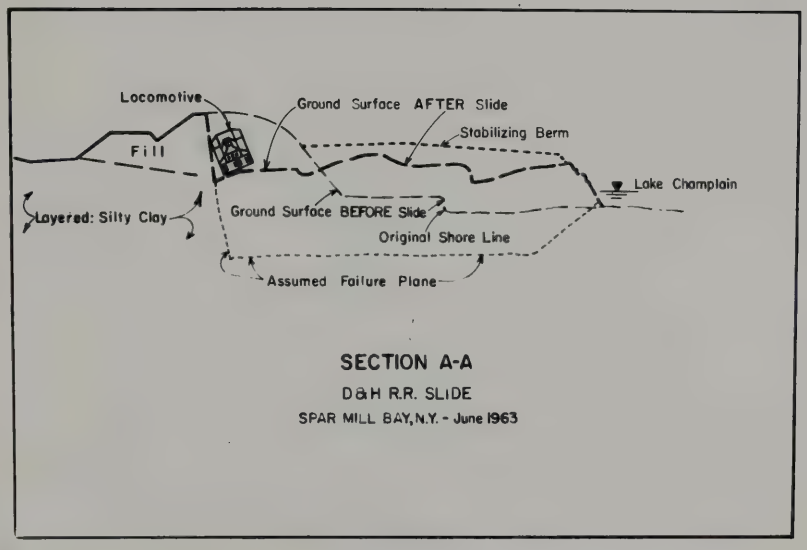

FIGURE 2

CROSS SECTION OF D&H R.R. SLIDE
SPAR MILL BAY, N.Y.
JUNE 1963

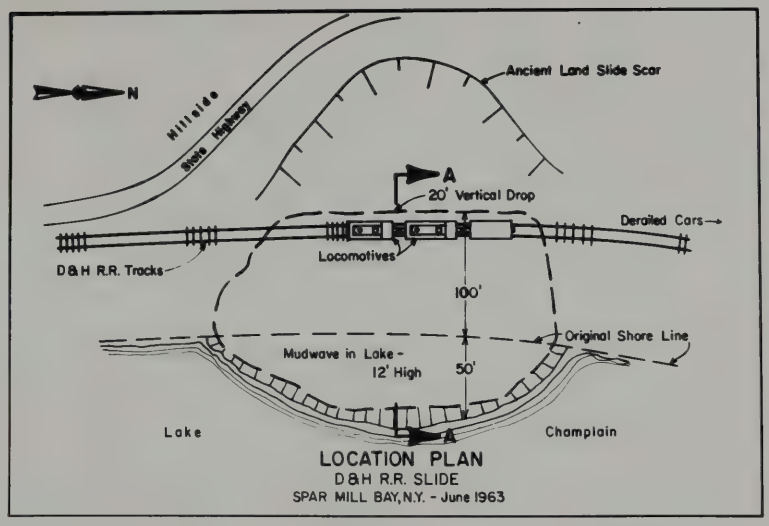

FIGURE 3

PLAN OF D&H R.R. SLIDE
SPAR MILL BAY, N.Y.
JUNE 1963

FIGURE 4

PHOTO OF EMBANKMENT FAILURE
D&H R.R. - SPAR MILL BAY, N.Y.
JUNE 1963

FIGURE 5

PHOTO OF MUDWAVE IN LAKE CHAMPLAIN
D&H R.R. EMBANKMENT FAILURE
SPAR MILL BAY, N.Y.
JUNE 1963

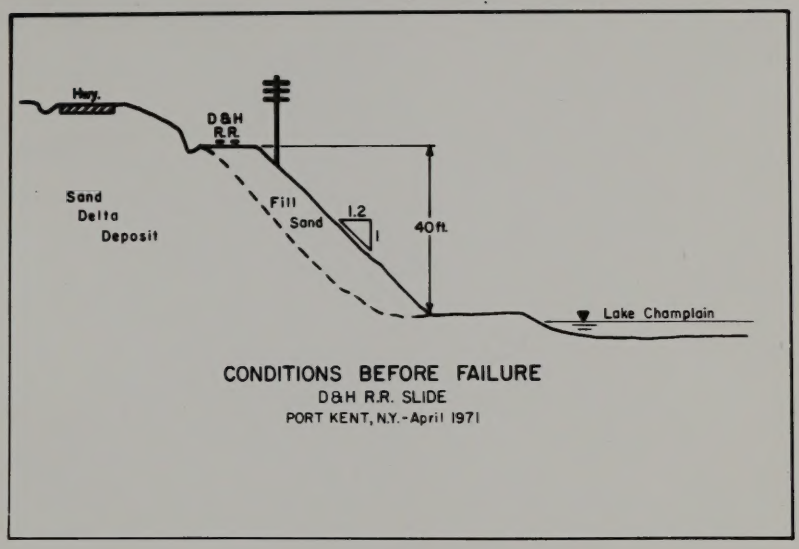

FIGURE 6

SECTION SHOWING CONDITIONS
BEFORE FAILURE
D&H R.R. SLIDE, PORT KENT, N.Y.
APRIL 1971

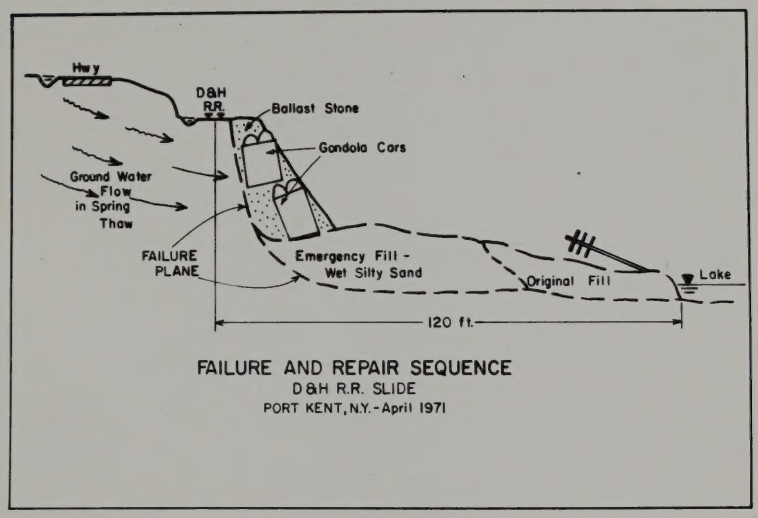

FIGURE 7

SECTION SHOWING FAILURE AND
REPAIR SEQUENCE
D&H R.R. SLIDE
PORT KENT, N.Y.
APRIL 1971

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